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The correlation between air pollution and the allergic rhinitis incidence: Erzincan model

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Abstract. – OBJECTIVE: Air pollution is a significant public health problem in our country as well as all over the world. The effects of air pollutants on the respiratory tract are well-known. This study aimed to evaluate the relationship between the changes in air pollutant parameters during the year and the number of patients who applied to ENT outpatient clinics due to allergic rhinitis in the Erzincan city center between January 1, 2020, and December 31, 2022.

PATIENTS AND METHODS: In this cross-sectional, descriptive study, average 24-hour PM_{10}, $PM_{2.5}$, SO_2, NO_2, and CO measurements were taken in the city center between January 1, 2020, and December 31, 2022, using the Air Quality Monitoring Stations website of the Ministry of Environment and Urbanization. All allergic rhinitis patients who applied to ENT outpatient clinics were included in the study. The data analysis used median, minimum (min), maximum (max) values, percentages, and Spearman Correlation tests for descriptive statistics.

RESULTS: According to the WHO limit values, the number of days exceeded in all parameters during the specified years in Erzincan was found to be quite high. When the number of patients who had been admitted to ENT outpatient clinics was examined, a significant correlation was found between the average SO_2, CO values and the number of hospital admissions for 2020, and between the average PM10, SO_2, NO_2 and CO and the number of hospital admissions for 2021.

CONCLUSIONS: Environmental control and public health strategies should be implemented to address this increasingly complex problem.

Key Words:
Air Pollution, Allergic rhinitis, Erzincan.

Introduction

Air pollution is defined as the change in the composition of the air and the presence of pollutants in the ambient air in a way that will harm human health or welfare or create other harmful environmental effects[1]. The proliferation of toxic chemicals and the increasing use of motor vehicles are significant sources of air pollution[2].

According to World Health Organization (WHO) data[3], in 2019, 99% of the world's population lived in areas where WHO air quality guidelines were not met. Outdoor air pollution is estimated to cause 4.2 million premature deaths worldwide in 2019. It is estimated that approximately 37% of these deaths are caused by ischemic heart disease and stroke, 18% are caused by chronic obstructive pulmonary disease, 23% by acute lower respiratory tract infections cause, and 11% are caused by cancer[3].

The most common ambient air pollutants encountered in our daily lives are particulate matter (PM), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO), and carbon dioxide (CO_2). They are generally used in fuel combustion and as indicators of traffic-related air pollution. Both short-term and long-term exposure to these pollutants can cause many health problems. With economic development, air pollution concentration levels tend to increase significantly if effective remedial measures are not taken. In the mid-twentieth century, total suspended particle (TSP) levels remained very high in some major cities. In London in 1952, ambient TSP and SO_2 levels reached several thousand micrograms per cubic meter[4]; also in Shenyang, a heavy industry city in northeast China, TSP and SO_2 levels increased to hundreds to thousands of $\mu g/m^3$[5].

Allergic rhinitis (AR) is a chronic inflammatory disease of the nasal mucosa caused by IgE-mediated early and late-phase hypersensitivity responses[6]. Its prevalence has increased recently and has become a prevalent disease affecting 20% to 50% of the world's population[7]. Symptoms of AR include runny nose, nasal con-

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gestion, itching, and recurrent sneezing. It is also often accompanied by allergic conjunctivitis with symptoms that may include itchy, red, watery, and/or swollen eyes[8]. In the past, rhinitis was viewed as a minor illness because the symptoms were not life-threatening. However, it is known to significantly reduce the quality of life due to impaired well-being, sleep, and daily activities[9,10]. In addition to the patient impact, AR causes a significant economic burden[11]. According to the data of the Asthma and Allergy Foundation of America, approximately US$ 17.5 billion was spent on health-related costs of AR in 2010, and affected individuals received 16 million doctor visits due to AR[12].

In general, environmental and occupational pollutants are known to irritate the nasal mucosa, causing the release of inflammatory mediators and increased nasal hyperreactivity, which overlaps with the symptomatology of atopic diseases such as AR[13]. In animal experiments, exposure to ozone, automobile smoke, or city air has increased susceptibility to diseases, especially respiratory infections[14]. Numerous studies[14-16] on the exposure of air pollution in the upper respiratory tract have clearly shown the effect of air pollution on rhinitis. In a large epidemiological study conducted in Brazil, a higher incidence of rhinitis was reported in children living in areas with air pollution compared to those living in unpolluted areas[15]. A survey-based study has shown a reduction in respiratory symptoms with reductions in air pollutant levels in Germany[16].

The aim of our study is to evaluate the changes in air pollutant parameters during the year in Erzincan city center between January 1, 2020, and December 31, 2022, and the cases of exceeding the limit values of our country and the World Health Organization. In addition, it was aimed to evaluate the relationship between the levels of these parameters and the number of patients presenting to ENT outpatient clinics with rhinitis symptoms and the distribution according to the seasons.

Patients and Methods

In this cross-sectional, descriptive study, data were obtained from Erzincan and Traffic stations (within the city center) using the Air Quality Monitoring Stations website of the Ministry of Environment and Urbanization between January 1, 2020, and December 31, 2022. In the province of Erzincan, air quality measurement is carried out at two stations, Erzincan and traffic, using fully automatic devices installed by the Ministry of Environment and Urbanization. The measurement data collected at the measurement stations are transferred to the Environment Reference Laboratory Data Operation Center of the Ministry of Environment and Urbanization, monitored, and published simultaneously at www.havaizleme.gov.tr. Average 24-hour PM_{10}, $PM_{2,5}$, SO_2, NO_2, and CO measurements were downloaded on the specified dates, and the data were compared with the local threshold values of the World Health Organization (WHO) and Turkey. The daily and annual threshold values of the WHO and our country are presented in Table I[17]. All allergic rhinitis patients who applied to the ENT polyclinics of Erzincan Mengücek Gazi Training and Research Hospital between January 1, 2020, and December 31, 2022, were included in our study. The number of applications was evaluated according to years and seasons; the relationship between the measured parameters and the number of applications was examined.

Statistical Analysis

Data were recorded and analyzed in the Statistical Package for the Social Sciences 22.00 program (IBM Corp., Armonk, NY, USA). The normality of the distribution of the variables was examined using the Kolmogorov-Smirnov test. Data that did not show normal distribution were expressed as median and minimum (min)-maximum (max) values and percentages for descriptive statistics. Spearman Correlation tests were used for analysis. $p<0.05$ values were considered statistically significant. Before starting the study, approval was obtained from the Erzincan Binali

Table I. Limit values applied in air pollution parameters of WHO and our country[17].

	Measurement period	WHO (2021)	Turkey
PM_{10} (µg/m^3)	Daily	45	50
	Yearly	15	40
$PM_{2,5}$ (µg/m^3)	Daily	15	-*
	Yearly	5	-*
SO_2 (µg/m^3)	Daily	40	125
	Yearly	-*	20
NO_2 (µg/m^3)	Daily	25	-*
	Yearly	10	40
CO (µg/m^3)	Daily	4	10

*Undeclared limit values in WHO and Turkey.

Table II. The averages of the air quality parameters for years of the two air quality measurement stations in the province of Erzincan.

Stations	Parameters	Years [median (μg/m³) (min.-max.)]		
		2020	2021	2022
Erzincan I	PM_{10}	59.6 (10.1-187.6)	42.9 (10.7-187.2)	55.9 (16.2-245)
	SO_2	4.5 (2.3-31.5)	4.7 (1.8-25.2)	4.7 (2.1-25.2)
	NO_2	30.6 (7.7-111.5)	25.3 (5.1-111)	28.3 (4.4-95.8)
Erzincan II Traffic	PM_{10}	40.8 (8.7-143.9)	39.9 (10.1-233)	47.1 (12.2-219)
	$PM_{2,5}$	19.7 (3.5-101.9)	20.6 (3.1-184)	17.8 (3.8-185)
	SO_2	6.1 (1.9-43.9)	7.6 (2-61.5)	7.2 (3.1-70)
	NO_2	61.9 (29-111)	51.3 (15.7-127)	54.4 (21.7-107)
	CO	909.5 (337-3,118)	890 (287-4,216)	979 (456-2,755)
	N (Patients)	4,745	6,252	12,596

Yıldırım University Faculty of Medicine Clinical Research Ethics Committee, and the study was conducted in line with the principles of the ethics committee (decision no: 2023-02/7). Written informed consent could not be obtained from the patients included in the study due to the study's retrospective design.

Results

The averages of the air quality parameters for 2020, 2021, and 2022 of the two air quality measurement stations in the province of Erzincan are given in Table II. Maximum PM_{10} measurement over three years was 187, respectively; 233 and 245 ug/m³ (2020, 2021, 2022), while the maximum SO_2 measurement was 43.9; 61.5, and 70 ug/m³ (2020, 2021, 2022). In 2020-2022, 23593 patients were admitted to our hospital due to allergic rhinitis.

The number of days that the limit is exceeded for the parameters measured in Erzincan in 2020, 2021, and 2022 according to the local limit values of WHO and our country is given in Table III. Since the daily threshold of WHO is lower than the threshold values of our country, the number of days exceeded for PM_{10}, SO_2, and CO was found to be higher, respectively, compared to years. Since the daily limit values for NO_2 and $PM_{2,5}$ in our country are not specified in our regulation, only the number of days exceeded according to the limit values of WHO is shown in the Table III.

When the average air pollution parameters in 2 stations in Erzincan and the number of patients

Table III. The number of days that the limit is exceeded for the parameters measured in Erzincan in 2020, 2021, and 2022 according to WHO and the local limit values of our country.

Stations	Parametreler	Number of days exceeded the limits - WHO/ TR		
		2020	2021	2022
Erzincan I	PM_{10}	215/190	161/129	219/199
	SO_2	180/0	0/0	0/0
	NO_2	190/-*	170/-*	197/-*
Erzincan II Traffic Station	PM_{10}	168/140	147/127	162/142
	$PM_{2,5}$	210/-*	218/-*	180/-*
	SO_2	4/0	7/0	11/0
	NO_2	230/-*	323/-*	362/-*
	CO	0/0	1/0	0/0

*Daily limits for NO_2 and $PM_{2,5}$ for our country were not declared.

who applied to our hospital's ENT outpatient clinics were examined, there were significant correlations between the average SO_2 and CO values for 2020 and the number of hospital admissions and the average number of applications with PM_{10}, SO_2, NO_2 and CO for 2021. A significant correlation was found between them (Table IV).

When PM_{10}, $PM_{2,5}$, SO_2, NO_2, and CO values were compared according to the seasons, significant differences were found between winter and summer in all parameters in 2020, 2201, and 2022, except SO_2 for 2020 ($p<0.05$).

When the number of patient admissions was examined according to the seasons, a significant correlation was found between the $PM_{2,5}$, SO_2, and CO values in the winter season for 2020 and the number of admissions (r: 0.23, *p*: 0.007; r: 0.49, *p*: 0.0001; r: 0.67, *p*: 0.0001, respectively). A significant positive correlation was found between patient admissions in the winter season and PM_{10}, $PM_{2,5}$, and CO values for 2021 (respectively *r*: 0.16, *p*: 0.02; *r*: 0.19, *p*: 0.01; *r*: 0, 18, *p*: 0.01). In the 2022 analysis, a significant relationship was found only between SO_2 and patient admissions (*r*: 0.36, *p*: 0.001).

Discussion

Erzincan has a high plain floor as a geographical settlement and is surrounded by mountain ranges exceeding 3,000 m. This morphological situation impacts the climate of the Erzincan Plain. The stagnant cold weather conditions lasting for days increase the number of windless days between November and March in the plain and cause cold and frosty conditions in the increasingly polluted air. When these stagnant weather conditions last 4-5 days, the air pollution caused by the smoke and particles emerging from the systems used for heating, especially over the city of Erzincan and all the settlements on the plain, increases significantly[18].

Measurements made in Erzincan city center in 2020, 2021, and 2022 show that air pollution is a serious problem. When PM_{10} values are analyzed according to WHO and Turkey's national threshold values, it is seen that the limit values are exceeded in almost half of the year. Since the daily limits of our country for $PM_{2,5}$ and NO_2 are not specified, they have been evaluated according to the WHO limit values. Although there is no number of days exceeding in the limit values for our country, it has been observed that they are exceeded in both short and long terms according to WHO. On the other hand, there is no day to be missed for CO.

The health effects of air pollution, known as the third leading cause of death from non-communicable diseases, have been demonstrated in previous studies[19,20]. Exposure to pollutants is known to increase the risk of developing non-communicable respiratory diseases such as asthma, chronic bronchitis, chronic obstructive pulmonary disease and allergic rhinitis.[21]

In the analysis[22] of 1,408 individuals in two European cohort studies, it was shown that long-term exposure to PM_{10}, $PM_{2,5}$, and NO_2 was associated with higher severity of rhinitis. They obtained valuable results in the systemic review and meta-analysis of 35 studies by Li et al[23]. This study evaluated research in Asia and developing countries, showing that $PM_{2.5}$, PM_{10}, NO_2 and SO_2 have a significant effect on allergic rhinitis. In addition, PM_{10} and SO_2 levels were found to have significant and higher effects on allergic rhinitis in European countries[23]. In two studies[24,25] con-

Table IV. The relationship between hospital admissions and air pollution parameters by years.

Parameters	Number of patients					
	2020		2021		2022	
	r*	*p***	r*	*p***	r*	*p***
PM_{10}	0.06	0.22	0.13	0.01	0.03	0.51
SO_2	0.06	0.23	0.09	0.07	0.11	0.05
NO_2	0.33	0.0001	0.12	0.02	0.01	0.85
PM_{10}	0.11	0.05	0.13	0.008	0.02	0.62
$PM_{2,5}$	0.19	0.0001	0.17	0.002	0.04	0.38

*r: correlation coefficient **p: statistical significance.

ducted in China, it has been shown that there are significant increases in the number of allergic rhinitis outpatient clinics with the increase in $PM_{2,5}$, PM_{10}, NO_2, and SO_2 levels. Two studies[26,27] in our country showed that outdoor air pollution adversely affects allergic rhinitis symptoms and chronic rhinitis prevalence.

In contrast to these studies, Villeneuve et al[28] reported no statistically significant relationship between daily air pollution levels and the number of doctor's visits for rhinitis among the elderly in Toronto. In the study conducted by Annesi-Maesano et al[29], no correlation was found between air pollution levels and allergic rhinitis score. A positive correlation was found Mady et al[30] by between exposure to black carbon and some rhinitis symptoms, regardless of allergic sensitization status, and no results were found for $PM_{2,5}$.

Limitations

In our study, a relationship was found between admissions to the otolaryngology outpatient clinic due to allergic rhinitis and air pollution.

Our findings are important in terms of revealing the effects of air pollution, which is a preventable public health problem. The presence of more than one reason other than air pollution in the etiology of allergic rhinitis is a limitation for our study. It is impossible to investigate these causes in our retrospective study. A prospectively planned study examining the effects of air pollution on allergic rhinitis in terms of features such as reasons for admission, gender, and age will help determine cause-specific and influential factors.

Conclusions

Exceeding the daily-monitored air quality limit values in Erzincan is at a level that poses a health threat and affects applications to otolaryngology clinics. Healthcare policymakers must implement environmental control and public health strategies to address this increasingly tricky issue.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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Authors' Contribution

Study conception and design: S. Salcan and İ. Salcan. Data collection and input: S. Salcan. Analysis and interpretation of the results: S. Salcan and İ. Salcan. Draft manuscript and preparation: S. Salcan and İ. Salcan. All authors gave their final approval and agreed to be accountable for all aspects of the work.

Ethics Approval

Written permission was obtained from the Erzincan Binali Yıldırım University Faculty of Medicine Clinical Research Ethics Committee (2023-02/07). This study was conducted in conformity with the Declaration of Helsinki.

Informed Consent

Written informed consent could not be obtained from the patients included in the study due to the study's retrospective design.

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